# The Tribune Radio—Comment and Advice—By Jack Binns

## Most Sensitive Receiver for Radio Known

### This Is Title Bestowed on Super-Heterodyne System, One of E. H. Armstrong's Epoch-Making Inventions

### Valuable on Short Waves

### Reproduces Radio Telephone Speech Clearly Without Distortion or Howling

When E. H. Armstrong demonstrated his new super-regenerative system before the Radio Club of America, he made a comparative reference to the super-heterodyne receiver, which he called the Rolls Royce of radio. Since that time I have received such a number of inquiries regarding this system that I am going to give a brief outline of it.

The super-regenerative is one of the epoch-making inventions of radio, and was produced by Armstrong in 1919. It is undoubtedly the most sensitive receiver, as well as the most selective known to the radio art. The principle upon which it is based is that of detecting at one frequency and amplifying at another. The only drawback to it from the average radio fan's point of view is the cost, as it employs from seven to nine vacuum tubes; although there is no theoretical limit to the number that can be used.

It was this system that enabled Paul Godley to successfully receive no less than twenty-nine American amateur stations at his temporary station in Ardrossan, Scotland, 3,000 miles away, despite the fact that none of the amateur stations was using more than one kilowat of energy for transmission. Besides being extremely sensitive, the super-heterodyne system also has an important bearing upon the development of the short wave ranges.

**Important on Short Waves**

Perhaps no better way of expressing this can be given than in the words used in the letters patent granted to Armstrong on June 8, 1920, which are as follows:

"The limit of the practical amplifier at present is about 100 meters and the range of wave lengths from 0 to 100 meters are unused at the present time because of the difficulties of amplifying and detecting them. High frequency amplifiers have been constructed to operate on wave lengths as low as 200 meters, but with only fair efficiency.

"The present invention discloses a method of indirect amplification and reception which operates independent of the frequency of the incoming oscillations and which, therefore, opens up the great range of wave lengths below 100 meters and makes possible, in fact, the use of waves of a few meters in length whereby radio communication by directed beams of energy becomes a practical proposition. The present invention may also be used to great advantage on wave lengths from 300 to 1,000 meters with a considerable gain in selectivity and sensitiveness, as compared to any known methods."

**How System Operates**

A diagram showing the connections for the super-heterodyne, using seven vacuum tubes and one heterodyne tube, is reproduced in the Radio Primer on this page. The manner in which it operates is as follows. Assume that we are listening for one of the broadcasting stations operating on a wave length of 360 meters. The frequency of this wave is determined by dividing 300,000,000 by the length of it, which gives us aproximately 833,333 cycles per second. In other words, wave lengths of 360 meters consist of alternating currents having a complete change from positive to negative that number of times per second.

Now it is a well known fact that amplification of such high frequencies presents very serious difficulties, while it is much easier to amplify lower frequencies. The problem which the super-heterodyne principle solves, therefore, is one of converting the frequency of the incoming currents down to some pre-determined lower frequency which is much more readily amplified.

The manner in which this conversion is attained is by means of the heterodyne or "beat" principle; only in the super-heterodyne principle the beat frequency is adusted to a point above human hearing. Heterodyne literally means "other power," and it is the principle whereby a local source of power is employed in radio work to produce an audible frequency by making the local power source clash with the incoming currents at a predetermined number of times per second.

**Describing the Heterodyne**

This can be illustrated, for example, by assuming that we are to receive from a transmitting station using continuous waves of a wave length of 5,000 meters, or a frequency of 60,000 cycles per second. This, of course, is far above the human hearing. If we connect up a small vacuum tube so that it acts as a transmitter, we can cause it to produce oscillations of any desired frequency by adusting the amount of inductance and capacity in the circuits about it. Therefore, if we set this tube oscillating at 60,500 cycles per second, the wave it produces and the wave which is being received on the aerial will be out of phase with each other 500 times per second, and the result is a note in the telephone receivers equivalent to the pitch caused by 500 vibrations per second.

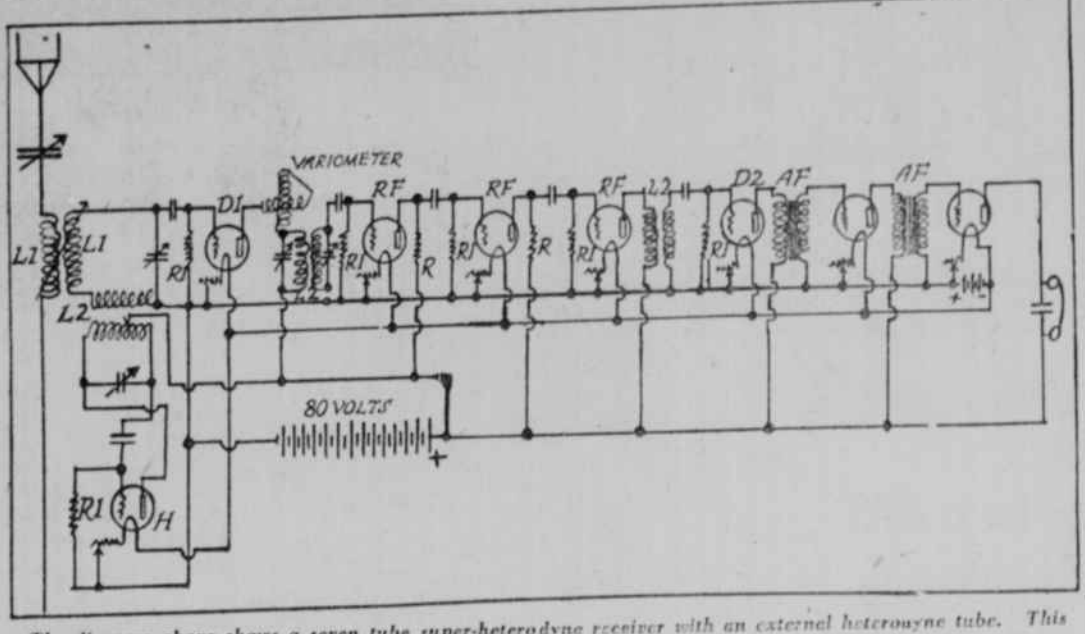
Now there is no reason why the frequency resulting from this effect should be so low. It can be made well above human hearing, and this is exactly what is done in the super-heterodyne system. The incoming oscillation and the oscillation produced by the local heterodyne tube are passed through the first detector, and converted to a lower frequency, which is transferred to the high frequency amplifier through the tuned circuits which are shown after the first detector tube.

**Converted Current Amplified**

After the strength of the converted oscillations have been built up by the high frequency amplifier, they are passed again through a transformer, and then rectified by the second detector tube and passed through the telephones, or carried on through two stages of audio frequency amplification before being put through the telephones.

There is no limit to the number of stages of amplification that can be used with this system, provided that each intermediate stage of high frequency amplification is at a lower frequency than the previous stage, and that the conversion from one frequency to the other is made with the use of a heterodyne at each stage.

## Monarch of Radio Receivers—Armstrong's Super-Heterodyne



*The diagram above shows a seven tube super-heterodyne receiver with an external heterouyne tube. This is the most sensitive and most selective receiver known at the present time. The coils L1 are the primary and secondary tuned to short wave lengths. The coils L2 can be any form of oscillation transformer tuned to frequencies of 100,000 cycles per second, or in other words with a wave length range of 3,000 meters. The plate variometer is of the regulation short wave standard type and tunes the first detector for regeneration. The tube marked H is the heterodyne and the circuit about it is arranged to produce frequencies of 100,000 cycles. The combined frequencies of the incoming wave and the heterodyne tube are converted to a lower frequency and amplified by the tubes marked RF. These tubes are shown in the diagram as resistance coupled, the resistances marked R having a value of 100,000 ohms. The resistances shown as R1 are grid leaks and have a resistance of 5 megohms. The diagram shows two stages of audio frequency amplification after the second detector tube which is marked D2.*

## First Aid for Radio Enthusiasts

**Super-regenerative Trouble**

Question—I have constructed the Armstrong super-regenerative hook-up from the information obtained and also from your advice. I have adhered to this hook-up very rigidly regarding the voltage and polarities as shown and also regarding the various inductive elements, with the exception of the two choke coils. In place of the 100 millihenries iron core choke coil I have used an Acme iron choke coil, with approximately 2,000 turns of wire in the coil. I do not know the rating of this choke, but I have figured, according to standard formula, about fifty millihenries. I have also substituted the primary and also secondary windings of transformers for a choke coil. For the ten millihenries choke coil I have used various D. L. honeycomb coils from 300 to 600 turns. The substitution of these various elements does not seem to alter the results so that you can notice it, and at the same time I do not get the proper results. I can just barely hear WJZ on the indoor coil. This indoor coil is constructed of standard aerial wire, twelve turns spaced one-half inch, measuring three feet on the diagonal and is similar in shape to the one demonstrated at Havemeyer Hall. The vario-coupler that I use is a Tuska vario-coupler with an anti-capacity switch for loading the secondary. I get WJZ on the position of this switch for 200 meter waves, but not at the other positions. I have also tried this hook-up on the aerial with a little better result, but I do not get any results when the ground connection is made. Of course, I understand that it is practically inoperative on an aerial connection, but I do not understand why I am unable to get the proper result from this arrangement, and I hope you can enlighten me. Are honeycomb coils all right for the ten millihenries chokes? In the above hook-up I use five-watt tubes and my B batteries are made up of eight storage B batteries, totaling an even 200 volts. I also notice that there is a great deal of body capacity about this hook-up, which, I suppose, is on account of not having the elements more compact in arrangement. I have also found that a .0005 variable condenser across the vario-coupler secondary terminals has helped somewhat on this hook-up with the material on hand that I have used. In adjusting the above hook-up I find that the variation of the condenser in series with the 100 millihenries choke coil and the resistance has no effect whatever, regardless of the setting of the condenser.—A. C. C.

Answer—Your trouble with the super-regenerative circuit seems to lie in two places. First, the feed-back coil, and second, in the iron core choke of the filter circuit. There should be no condenser across the feed back coil. I do not think that you will get the same results through loading as you will by having the coil compact. I would suggest that you rewire the secondary of the vario-coupler, putting on about twice the number of turns that it has at present and eliminating the switch. The fact that the variable condenser in series with the iron core choke you are using does not vary the conditions would indicate that the choke coil is not suitable. I think that you can obtain one of these choke coils through some telephone supply house. You can use the 400-turn duolateral coil for the 10 millihenries high frequency choke.

**Substitute Parts for New Set**

Question—I desire to construct Armstrong's super-regenerative receiver, but there are some things which puzzle me greatly. I would appreciate answers to the following questions: 1. If UV 201 tubes are used what must be the voltage for batteries B1 and B2 in your diagram of July 2? 2. Does L1 of the vario-coupler have any inductance taps; also would it be possible to construct this out of two cardboard tubes? If so, how many turns on B1 and on L2, and what size tubes for L1 and L2, also the size of the wire? 3. What length of wire and what size is needed to wind the two 12,000 ohms resistance coils—R1 and R2? 4. Can dry cells be used for the "C" batteries? If so, how many for the first two biasing batteries? 5. Can duo-lateral coil No. 400 be used for coil L4? 6. What is the constant for the phone fixed condenser? 7. Can a D. L. coil—D. L.—1,000, 100 millihenries inductance—be used in place of the iron core choke coil L4?—L. W. B.

Answer—1. If you use UV 201 tubes, I would suggest that you use 80 volts on the plate circuits of the first two tubes and 120 volts on the plate circuit of the third tube. 2. Any standard vario-coupler of a wave length range of from 150 to 600 meters will do for the coils L-1 and L-2, with the exception that about twice the number of turns must be placed on the rotor. If you desire to construct this yourself I would suggest that you do so upon a four inch tube for the primary with eighty turns of No. 24 DSC wire. Tap each turn for the first ten turns and then a tap for every succeeding ten turns. These tappings should be connected to two separate switches in order to vary the inductance in that coil. The rotor should be wound with 100 turns of the same sized wire on a three inch rotor ball, which, of course, may make it necessary to use bank winding. 3. I would suggest that you purchase the 12,000 ohms resistance. These are made of a composition specially prepared for that value, and can be bought very cheaply from any recognized telephone supply house. 4. For the "C" batteries of the first two tubes you can use two pocket flash light cells connected in series for each tube. For the third "C" battery, an ordinary 22½ volt "B" battery will do. 5. A duo-lateral coil, No. 400, can be used as the high frequency choke shown as coil L-4. 6. The value of the fixed condenser should be .0025 mfd. capacity. 7. A duo-lateral coil cannot be used for the iron core choke. This must be a special type of iron core choke that is used in telephone filter work.

**Using Five Watt Tube**

Question—I have the following questions to ask concerning the Armstrong regenerator: 1. What kind of condensers are C2 and C4? 2. I am able to buy Cunningham type UV 201 (hard), but they are not 5 watt. However, I can also get radiotron 5 watt tubes UV 202, taking 7.5 volts for filament with a plate voltage of 350. Would the latter tube work well on 200 volts as prescribed, or would it be possible to use type UV 201 for the first two tubes and type UV 202 for the third tube?—C. E. M.

Answer—Condenser C2 is a fixed condenser of .0025 mfd. capacity. This is a standard size, and the cost is very small. C4 is a fixed condenser of .005 mfd. capacity, and can be purchased in the same way. I think that you will be able to use UV 201, but in that event you would only put 80 volts on the plates of the first two tubes and 120 on the plate of the third tube. The UV 202 is the correct tube to use, as that is a 5 watt tube. In fact, you can use any voltage up to 350, and the greater the voltage the greater the volume in your telephones.

**On Radio Frequency**

Question—I have a one-step radio-frequency amplifier using impedance coupling, which I have been using rather successfully for some time, and now would like to make a two-step radio-frequency amplifier, using the same coupling. Could you please give me a diagram for such an amplifier? Also, could you tell me how I can, by means of jacks or switches, put one-step, two-step, or none whatever, of radio amplification between a single circuit regenerative tuner and an audion detector?—G. C. D.

Answer—What you really show is tuned coupling and all that will be necessary will be to put another tube in circuit in the set, in exactly the same way as you have your present one stage radio-frequency amplifier and repeat the circuit between them. If you use jacks for this purpose I do not think that your results will be so very good, because of the capacity effect of the jack itself, and I would advise against it. I think that your present results can be improved if you put 22½ volts on the plate circuit of the detector tube and 45 on the radio-frequency tube. You can make your second stage of radio-frequency amplification in a separate panel, and arrange it so that it can be joined to the other between the first stage and the detector, but I would advise that your leads be made as short as possible.

**Call Letters of Stations**

Question—Will you please be kind enough to tell me who 2XB, 2XJ and 2XW are? Also, what are the names of the stations located at Clarksburg, Pa.; Bridgeport, Pa., the steamship America and Deal Beach?—R. R. H.

Answer—Station 2XB belongs to the Western Electric Company, at New York City; 2XJ is located at Deal Beach, New Jersey, and 2XW is the Pennsylvania Railroad Company's tugboat Lancaster. The call letters of the steamship America are KDOW. Unless you can give me the names of the individuals or concerns running the stations at Clarksburg, Pa., and Bridgeport, Pa., it will be impossible for me to advise you what the call letters are for these stations.

**Merits of Two Systems**

Question—I am thinking of departing from the simple regenerator set consisting of two stage amplifier, detector bulb, condenser, variometer and variocoupler to either one of the following, and wish to ask your advice for best results. First: Loop antenna and three stage radio frequency amplifier, using the loop-antenna with the vario-loop, .006 mfd. with UV 1714 radio-frequency transformer with a range of 200 to 5,000 meters—or Armstrong super-regenerative set. Do you know which one of these sets would be best in our locality? I am very desirous of getting a set which will work well with loud speaker, receiving stations 125 to 200 miles from here. The regenerative set will not do this, and the only station we can use it on at all and that not always satisfactorily, is WGY, which is sixty-five miles from here. We are located about 120 miles from Newark and also Springfield, and we have periods of three or four weeks when we cannot use the regenerative sets at all, due to atmospheric conditions. Will you please tell me if the loop antenna used in super-regenerative sets is sufficient to bring any station, such as Pittsburgh or Detroit (which do not come in on the regenerative set), if the atmospheric conditions are favorable?—F. S. Van V.

Answer—It is somewhat difficult to state just exactly what the super-regenerative receiver will actually do so far as distance is concerned, but it is a brand new system and there is still a lot to be learned about it in respect to distance. In any case, however, I think it will be more efficient than radio-frequency amplification is on short wave work. I do not see any reason why you should not be able to receive Newark and Springfield with this system on a loud speaker, provided you use the diagram which was published in this newspaper. Of course, radio frequency can be used with an aerial, while the super-regenerative system cannot; but radio-frequency amplification on short waves is so very critical and so very tricky that it needs the utmost expert handling in order to obtain results. Static is just as bad on non-regenerative sets.

**Using Power Lines for Aerial**

Question—Can I use regular A. C. lighting circuit as aerial to receive music from the broadcasting stations? If so, what capacity of condenser shall I have to use? I have a regenerative vacuum tube receiver.—A. H.

Answer—A great deal depends upon the electric light circuit itself. If the lines come into your house overhead you are apt to get much better results than if they came into the house through a conduit. It is very difficult to predict results with this system, as everything depends upon your local conditions, such, for instance, as the amount of steel in the building, and upon the electric light circuit itself. In this particular case the condenser must be built so that it will withstand a pressure of at least 2,000 volts without the dielectric breaking down. Under the circumstances, therefore, it is necessary to have a properly constructed condenser, using mica as the dielectric. I think that you will find it much cheaper to buy a condenser of that character from some reliable concern than it will be to make them, and there will be less danger in using it.

Question—1. Are the copper sheets in back of the panel and between the variometers for avoiding body capacity very essential, or will it be all right without them? 2. What is the best way to tap the primary of the vario-coupler. 3. Must the variometers be placed 18 inches apart? 4. To what extent will a variable condenser help in a vario-coupler two variometer circuit regenerative hook-up? Will the set be just as good without it?—J. R.

Answer—1. The copper sheet on the back of the panel and between the variometers is very essential for the elimination of body capacity effect, and I would strongly urge you to use it. The copper sheeting, of course, should be grounded and care should be taken that the sheeting does not make electrical contact with any of the other apparatus. 2. The primary of the vario-coupler should have two tappings. The first should be a tap from each of the first ten turns; these taps should be attached to one switch—then the remaining turns should be tapped in groups of eight—each of the taps attached to the second switch. In this manner you will be able to bring in any number of turns into the circuit. 3. The variometers should be separated by the vacuum tube detector, but it is not necessary that they should be eighteen inches apart if they are shielded. 4. If you tap the vario-coupler in the manner that I have indicated it will be possible to work without a variable condenser in the aerial circuit, although, of course, a variable condenser will give much cleaner tuning.

**What Are Best Condensers?**

Question—Which is best, a variable condenser that has the plates spaced with washers or one that has the plates spaced by a mold? Would a set containing a honeycomb coil, a variable condenser, a series parallel switch and a crystal detector be very good?—D. H.

Answer—The quality of a variable condenser does not really rest on whether it is spaced by washers or by a mold, but rather on the distance between the plates and the area of the plates themselves. You cannot go wrong if you purchase variable condensers of recognized standard make. A set containing a honeycomb coil and variable condenser in conjunction with a crystal detector should work all right. I do not think for short wave work that it will be necessary to have the series parallel switch, but you must put the condenser in series with the aerial and the honeycomb coil.

## High Frequency Amplification Working Tips

### Hints for Those Wishing to Experiment With Cascade System Radio Frequency Amplification of Signals

### System Not Perfect Yet

### But Offers Scope for Those With Time and Means to Carry Out Experiments

In an article last Sunday the advantages and drawbacks of radio-frequency amplification were outlined, and the reasons given why up to the present time it has not been universally successful on short wave signals.

These difficulties have been overcome in a different way by the genius of E. H. Armstrong through the invention of the super-heterodyne and super-regenerative systems which function far beyond all expectations on short waves.

There is, however, quite a romantic interest in the use of radio-frequency amplification, and its development has been greatly forced in England, where the British amateurs are very much hampered by stringent government regulations, but has only recently been taken up here.

**Tuned System Tedious**

If the experimenter wishes to install tuned circuits between each tube in the radio-frequency section of his receiver, and then carefully and patiently tune each stage into resonance with the incoming signal, there is no problem to solve in using this form of amplification on short waves. This system, however, is extremely laborious and, moreover, very tricky. It requires the most delicate touch and expert adjustment, which come only after months of experience.

Since the development of the radio broadcasting system, however, the great growth of public interest in radio has given the necessary stimulus to seek a solution of the problems involved, and a number of engineers throughout the country have been steadfastly experimenting with transformers which will function successfully without adjustment with any of the types of vacuum tubes now on the market.

Some of these have been brought down to a fairly fine point of efficiency, but they still require that the operator shall observe certain fundamental facts in order that successful results can be achieved.

In all radio-frequency amplifying circuits it is absolutely necessary that a potentiometer should be used across the A battery which lights the filaments of the tubes. This stabilizes the entire circuit and enables the operator to put the proper amount of negative bias on the grids of the radio-frequency tubes. This function will be further assisted by placing a by-pass condenser of at least .001 mfd capacity across the grid lead and negative side of the potentiometer. One potentiometer and by-pass condenser can be used for all of the radio-frequency amplifying stages used in the set.

While it is possible to use a regenerative circuit in connection with radio-frequency amplification, this is not advised because it only adds to the difficulty of adjusting and balancing the receiver. It must not be forgotten that on short waves the phenomenon of regeneration is actually present in radio-frequency amplification.

**Beware of "All Wave" Transformers**

This is due to the capacity effect which exists in the grid and plate leads in the vacuum tube and the winding of the transformers. In fact, by carefully adjusting the potentiometer the entire set can be put into an oscillating condition just in the same manner as a regenerative set oscillates.

The radio fan who is intent in experimenting with radio-frequency amplification is warned against the radio-frequency transformers which claim to cover too wide a band of wave lengths. It simply cannot be done.

The following are a few hints of certain fundamentals that should be observed: First of all, radio frequency amplification in short waves is for the experimenter who has time and means to work with it. Only hard tubes can be used in connection with it. These tubes, of course, are not critical as to plate voltage, and at least 45 volts should be used in the plate circuits.

The potentiometer should be varied very carefully until the best signal results are obtained. The more the potentiometer is varied toward the positive side the more stable the set will operate, but the signals will be weaker. The more negative bias put on the grids by the potentiometer the stronger the signals will be until the oscillating point is reached. The set should be kept below this point.

## Radio To Be Used as Aid In Mine Rescue Work

### Bureau of Mines to Work on Problem of Apparatus for This Purpose

The Bureau of Mines of the Department of the Interior is engaged in studying the problem of applying radio apparatus in conjunction with mining operations, especially for uses in cases of emergency. One of the proposed applications is the establishment of a suitable broadcasting station at each mine, so that a radio distress call could be sent for assistance in the event of mine accidents.

It is expected that such a scheme would materially assist in mine rescue work, especially as rescue stations could be centrally located to a number of mines, and be equipped ready to rush to the scene of any mine disaster in its particular district.

Another problem that is engaging the attention of the experts of the bureau is the construction of small portable receivers which miners could take with them into the workings, so that in the event of an accident the rescuers could communicate with them. If this problem is satisfactorily solved the experts will then try to devise a small compact transmitting set for the miners, so that they could advise their rescuers just where they were located in case of accident.

The latter problem will be an extremely difficult one to solve, because the set must not only be compact, but it must be devoid of any sparking contacts that might ignite the gases in the mine. Such small sets as these would have to comprise a vacuum tube transmitter, probably in the order of a five-watt set. They would have to utilize some form of dry cell high voltage batteries for the plate circuits of the tube, as it would not be feasible to run high voltage generators in the workings.

## Electric Light Plug Aerials Should Be Chosen With Care

### Construction of Condenser Inside Plug Important; for Safety They Should Withstand Line Voltage

There seems to be some doubt in the minds of radio fans with regard to the use of the electric light system for the purposes of an aerial in places where it is impossible to erect an outdoor antenna. In fact, the conditions governing the use of a special plug in the electric light socket for this purpose are so varying that a review of the situation undoubtedly will be interesting.

In the first place, it is imperative that the fans use only such plugs as are made by well established, reputable concerns, and they also should make sure that the condensers in the plugs will withstand any voltages that might exist on the line, and that its dielectric is not made of paper. In this respect the Board of Fire Underwriters is passing on the plugs as fast as possible, and its stamp of approval will be a guard in the near future.

Of course, there are some receivers that will not even operate with an aerial, so it would be futile to expect them to work on the electric light wires. There is another important point which should be remembered, and that is that tuning with this system is much more critical, and consequently must be made more carefully than when an outdoor aerial is used. Therefore there are some cases where a little patience will bring success in the face of apparent failure.

There are some local conditions which make it impossible to obtain results with the plugs, just as they make reception with aerials extremely difficult. This is in buildings which are heavily shielded with steel structures, and places very close to power plants, and power lines carrying heavy voltage alternating currents. The distance the user is from the transformer in a system using alternating current for lighting purposes also is an important factor.

**Radio in Los Angeles Schools**

Los Angeles will have radio in twenty of its public schools before the fall sessions begin. The problem of having material broadcast that will meet the standards of the local pedagogues is a worrisome one.

## Big Power Tube Being Constructed, Marconi Declares

### Quartz Vacuum Tube Being Built in England, He States, Which Will Put 75 Kilowatts in Aerial

As the electron tube, or triode valve, or valve, as it is now generally called in England, is able not only to act as a detector, but also to generate oscillations, it has supplied us with an arrangement which is fundamentally similar for both transmitter and receiver, providing us also by a simple and practical method with the means for obtaining beat reception and an almost unlimited magnification of the strength of signals.

A result of the introduction of the triode valve has been that the basic inventions which made long-distance radiotelegraphy possible have become more and more valuable.

It has been so far our practice to use a plurality of tubes in parallel at our long-distance stations. High power has been obtained in practice up to 100 kilowatts in the antenna by means of a number of glass tubes in parallel, and for the present we are standardizing units capable of supplying 4 kilowatts to the antenna, in the numbers required and sufficient for each particular case.

Some difficulty was at first experienced in paralleling large tubes in considerable numbers, but no difficulties now occur with groups of sixty bulbs working on voltages of 12,000 on the plate.

I am told that no insurmountable difficulty would be encountered if it were desired to supply 500 kilowatts to the antenna from a number of these bulbs. The life of the bulb has been very materially increased and the 4-kilowatt units are expected to have a life, which, based on a great number of tests carried out both in the laboratory and at our Clifton station, should be well in excess of 5,000 hours.

The development of single unit tubes of considerable power is also progressing. We have lately concentrated on the production of high power tubes made of quartz, and two sizes of each bulb are now being made, one for 25 kilowatts to the antenna, and another for 75 kilowatts.—Guglielmo Marconi, in "Radio Broadcast."

**Improving Faulty Crystal**

Sometimes it is very difficult to get a sensitive spot on your crystal. Try the following plan: Take a discarded crystal, and pulverize it, but not very finely. Put some of this inside a metal casing and screw it into the cup of your detector. You will be surprised to note how quickly you can find a good spot now.

### Daily Radio Program

Sunday, July 23

**WJZ, Newark (360 meters)**

1 p. m.—Radio chapel services, by Rev. Paul Lindemann, St. Paul, Minn.
6:30 p. m.—"The Bubble Books That Sing," by Ralph Mayhew
6:45 p. m.—"Sandman Stories," told by Kasper Seidel
7 p. m.—Adventure stories for boys and girls, "The White Dogs of Arran," from "The Pool of Stars," by Cornelia Meigs.
7:30 p. m.—"Banff and Lake Louise," by L. O. Armstrong
8:15 p. m.—Musical recital by Alexander de Bruille, violinist.
9:15 p. m.—Musical program by Andrew Thomas Williams, basso. Program: "Caro Mio Ben," "Il Lacerato Spirito," "Donna, Vorrei Morir," "Go Down, Moses," "Nobody Knows the Trouble I've Seen," "Oh, Graveyard," "Deep River," "Just You," "Who Is Sylvia," "Thou Art Risen, My Beloved," "Love Lights the Way."
11 p. m.—Arlington official time.

**WAAT, Jersey City (300 Meters)**

6:55 p. m.—Tuning test.
7 p. m.—Concert by the Symphony Mandolin Orchestra of 14 instruments, all of the mandolin family. Program: "The Colored Guards," "Prince Charming," "Morning Song," "Pagani," "Love's Old Sweet Song."
7:30 p. m.—Announcements.
7:35 p. m.—"Jasmine Blossoms," "Melodie," "Montclair Galop," "Like a Lonely Rose," "Yankee Dandy."

**WBZ, Springfield, Mass. (360 Meters)**

8 p. m.—Church services, conducted by Adjutant [illegible], of the Salvation Army Industrial Corps.

**WGI, Medford Hillside, Mass. (360 Meters)**

8 p. m.—Radio church service. Music by [illegible] Quartet, "Abide With Us." Address, "Right and Wrong Thinking as a Source of Happiness or Misery," by the Rev. Frank Oliver Hall, D. D., of Winchester, Mass. Tenor solo, "O Love That Wilt Not Let Me Go," Dr. W. F. Ames. "Light of Life," "Galilee."

**KDKA, Pittsburgh (360 meters)***

10 a. m.—Services of Calvary Episcopal Church, Rev. E. J. Van Etten, rector, Harvey B. Gaul, organist and director.
1:45 p. m.—Children's Bible story, "The Man Whose Hair Was Bobbed."
2 p. m.—Radio Chapel at KDKA, conducted by Rev. E. A. Hibler, pastor, the First Christian Church, of Crafton, Pa.
7 p. m.—Services of Point Breeze Presbyterian Church, Dr. P. H. Barker, minister.

**KYW, Chicago (360 meters)**

3 p. m.—Radio Chapel services, conducted by the Rev. E. J. Alkin, pastor of the Methodist Episcopal Church of Riverside, Ill. Sermon on "Making a Life." The musical program by the church choir, with Mrs. Edwin De Camp, leader, Miss Della Keafter, soloist, and Miss Gladys Leland, pianist.
News and baseball returns.
*Central Daylight Saving Time.